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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,412,613**, on November 22, 2002, by **MCN BIOPRODUCTS INC.**, assignee of Rex W. Newkirk, David D. Maenz and Henry L. Classen, for "Filtration of Viscous Oilseed Slurries".

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ABSTRACT

Discloses a two stage filtration system for treatment of oilseed materials such as oil-extracted canola flakes to separate the low valued fibrous material dispersed by aqueous extractions. The filtration system receives a product slurry and passes the slurry through first stage filter which is an impeller type filter that operates to separate the slurry into a filtrate and a moist retentate. The moist retentate is further filtered in a second compression filtration stage to remove additional water. The first stage impeller type filter is a tubular auger arrangement or a mixing vessel having a filter medium as a portion of the vessel wall with an impeller blade closely fitted to the filter medium. The second stage compression filter is preferably a passage of decreasing cross sectional area such as a screw press or a belt press but can include a piston and vessel arrangement.

Filtration of Viscous Oilseed Slurries

Field of the Invention

This invention relates to a process of treatment of oilseed materials such as oil-extracted canola flakes to produce a food product.

Background to the Invention

Oilseed materials such as oil-extracted canola flakes are rich sources of valued proteins and carbohydrates. However, these materials also contain low valued fibrous materials such as hulls and straw. These are preferably removed to give a higher-value product.

One way to remove the low valued fibrous material is by aqueous extractions. In aqueous extraction processes, water is added to the vegetable starting material to form a thick slurry. Typically, the slurry is composed of 3 distinct phases: a liquid containing the soluble components of the starting material, a light solids phase composed of fine particles of cell meats in suspension; and a heavy solids phase composed of fibrous materials such as hulls and residual straw. Extraction processes are frequently designed to remove only the liquid phase from the slurry. Such processes utilize established separation techniques such as centrifugation that are designed to generate a clear liquid extract. However, the fine particles in suspension, which contain valued proteins and carbohydrates, are directed toward the extracted residue in any separation system that generates a clear extract.

Chemical modification is frequently employed to improve the solubility of proteins in the slurry. However, these modifications add cost to the process and can damage the nutritional value of the extract.

An alternative to chemical modification of the slurry and generation of a clear extract is to develop a mechanical separation system that directs the fines toward the extract and in so doing generates an extract consisting of both the liquid phase and the light solids phase containing the valued fines.

However, in the case of a thick viscous starting slurry of vegetable material, such as a slurry of oil-extracted canola flakes, obtaining efficient extraction of liquid plus light phase solids has certain difficulties. Compression-based filtration can be used to obtain an extract containing light phase solids. In this process the slurry is pressed with a filter media having pore opening or aperture sizes that permit passage of the light solid phase in the slurry, while retaining the heavy solids as an extracted presscake. An example of this type of process is shown in Canadian Patent Application 2,363,451 of MCN Bioproducts Inc. However, the thick viscous nature of the slurry results in compacting of the filter media and poor separation per unit area of filter media with considerable extrusion of slurry from the sides of the filter media. As such, direct processing of a viscous slurry of vegetable material by compression filtration requires extensive filtration area and slow process rates. As such substantial equipment is required for direct compression filtration, which drives up the cost of production. Similarly, the viscous nature of the Canola slurry does not permit adequate separation using established centrifugal filtration processes.

It is therefore desirable to develop a filtration system for viscous oilseed slurries, which system filters efficiently to separate an aqueous phase containing water soluble components of the oilseed and small particles of cell meats from the remaining vegetable matter. It is also desirable to have a filtration system which removes most of the water from the residue, so that it can be dried subsequently without great expenditure.

Description of the Invention

It has now been found that a sequential filtering operation which provides for efficient separation can be used with aqueous oilseed suspensions. In the sequential filtration system, there is a first stage with impeller-driven filtration, followed by a further filtration by conventional means, such as a centrifuge or a compression filter. Of the conventional means, compression filters are preferred. The invention will be disclosed in conjunction with the following drawings in which:

Brief Description of the Drawings

Figure 1 shows a first embodiment of filtration according to the invention;

Figure 1a shows a cut away view of an embodiment of a screw press compression filter variation suitable for use in the arrangement Figure 1;

Figure 2 shows the second embodiment of filtration according to the invention; and,

Figure 3 shows a third embodiment of the filtration according to the invention.

Detailed Description of the Invention

Impeller-driven filtration is a known filtration technique. In such filtration, a rotating impeller blade is passed close to a filter medium, as the slurry is passed over the same filter medium. The action of the impeller repeatedly sweeps the slurry over the filter medium, and minimizes compacting of the filter media. This results in efficient filtration per unit area of filter media. The pore opening or aperture size of the filter medium can be set to allow the passage of these fine solids in suspension while retaining solids of larger dimensions than the maximum aperture size of the filter on the filter medium as a residue. The sweeping action of the impeller can then be used to scrape the residue from the surface of the filter medium and remove it from the area where filtration is being carried out.

The residue obtained from the impeller filtration still contains a high percentage of moisture. Such residue cannot conveniently be dried, as the cost of drying would be prohibitive. Therefore, a second filtration stage is necessary in order to get a practical filtration at reasonable cost.

The second stage filtration can be either centrifugal or filtration by compression. Centrifugal filtration is not preferred, because the residue tends to be of large

bulk. This means that a large centrifuge is required, which increases the equipment cost of the operation.

Compression filtration reduces the volume available to the material to be filtered to effect filtering. Compression filtration may be of several types. A piston can be used to compress the residue material to be filtered against a filter medium, thereby squeezing out the remaining liquid.

Another type of compression filtration passes the material to be filtered through a passage of decreasing cross-sectional area. This may be achieved by the use of a belt press or a screw press. A belt press or screw press compression filter has the advantage that it is a continuous process, whereas the piston or centrifuge compression filtration systems are batch type processes.

The liquid which is extracted from the residue (by one of the centrifuge, piston compression press or belt press) can, if desired, be combined with the liquid from the impeller-filtration stage. Further, if desired, the minimum apertures of the filter medium in the piston compression press or the belt press can be of a size to permit the passage of small fragments of cell meat which may have been entrained in the residue, and which may fall out with the liquid being extruded.

The minimum aperture of all of the filter media can be chosen depending on the largest dimension of the solid particles that are desired to pass through the filter. Having regard to typical sizes of cell meat particles which are present. In the case of defatted canola, there are typically cell meat particles which have a largest dimension of up to about 75 microns. Therefore, it is most preferred to have filters with at least a 100 micron minimum aperture and preferably a 250 micron minimum aperture, to permit the cell meats to pass into the extract. The maximum aperture is not very critical, provided that it is small enough so that the fibrous materials present do not pass through. Typically, filters having maximum apertures of up to 2500 microns can be used, as typically most of the fibrous materials such as hulls and straw (which are to be retained in the retentate after filtration) do not pass through filters of this size. It is also possible to choose filters which will exclude some of the larger cell meat particles, if this is desired.

For example, filters having a maximum aperture of 50 microns can be used. These will pass the small cell meat particles, but not the larger ones.

Typically, the impeller-driven filter will have a filter medium with a minimum aperture of at least 100 microns, to permit passage of cell meat particles, and with a maximum aperture of approximately 250 microns. In the second (compression) filtering stage, where most of the cell meats have already passed through into the liquid phase, a filter having a smaller mesh can be used. For example, a filter of smaller maximum aperture can be used. A maximum aperture as low as 25 microns is suitable.

By "maximum aperture" and "minimum aperture" of the filter are meant the average maximum or minimum dimension (as the case may be) of the apertures of the filter. If the apertures are substantially round, then the maximum aperture and minimum diameter would both be the diameter. If they are approximately square in cross section, then the "maximum aperture" is the diagonal across the square and the minimum aperture would be the length of a side. Generally, it is preferred to have apertures which are regular in shape, rather than having apertures with one dimension (for example a length) much greater than another dimension (for example the apertures). The apertures should also be of approximately the same cross section through the entire thickness of the filter medium, to prevent particles getting trapped in the filter medium. Most filter media for impeller filtration or belt filtration are wire meshes, with regular sized apertures between alternate parallel wires of the mesh.

Several embodiments of the invention will be described with respect to the drawings.

Figure 1 illustrates a preferred embodiment of the invention. In Figure 1, defatted oilseed 1 and water 2 are placed into vessel 12. In vessel 12, they are mixed and agitated by means of an impeller 13 to form a slurry 100. Slurry 100 is removed from the vessel 12 periodically. This can be done in any convenient way, but is done in the present illustrated embodiment by means of exit pipe 15. Exit pipe 15 can be provided with suitable valving means 14 to close it until the defatted

oilseed 1 and water 2 have been blended to make a slurry 100 of the desired consistency.

Slurry 100, which is removed through pipe 15, is passed into an impeller-driven filter generally indicated as 20. The impeller-driven filter has a filter medium 21, which is preferably a mesh formed into a tube. The mesh surrounds an impeller 22, which is an auger which fits closely against mesh 21 forming the tube. The slurry 100 passes through the mesh tube 21, and the auger. As it moves the slurry forwardly and upwardly, the auger 22, through the close fit contact of the auger 22 with the mesh filter medium 21, sweeps the slurry across the filter medium 21. Suitably, the mesh is of sufficiently large mesh size (maximum aperture) so that the small pieces of nut meat which are in the slurry pass out through the mesh and fall, with the liquid, into container 23. Container 23, therefore contains liquid 101, which has been filtered from the slurry, and nut meat particles 102, which also passed through the mesh 22. Liquid 101 and nut meat particles 102 together are high in protein, and can be further processed to make a high value human or animal food or food supplement.

Emerging from the top of the auger 22 is a moist residue 103, which is the residue that remains after liquid 101 and nut meats 102 have been filtered from slurry 100. Residue 103 is passed into a compression filter in the form of a belt press 30. Belt press 30 is shown schematically as having endless belt 31, which rolls over rollers 33 and endless belt 32, which rolls over rollers 34. The belts are oriented so that they gradually approach one another as the mixture passes through from left to right in Figure 1. As the belts approach one another, liquid is squeezed from the residue 103 and falls as liquid 104 into container 35. At the nip 36 where belts approach most closely, the residue 103 has been bunched and extrudes from the nip 36 as a substantially solid presscake 105. This presscake is cut or crumbled by knife 40, and falls as product 106 into bin 41. Product 106 is suited for use as a feed for ruminant animals.

Figure 1a shows a cut away view of an alternate form of compression filter suitable for use with the system of Figure 1. The residue 103 is passed into a

compression filter in the form of a screw press 70. Belt press 70 is shown in cut away view of housing 71 to depict the manner of operation of this form of screw press. An archimedian screw 72 rotates within housing 71 to urge incoming residue 103 along the passage formed by housing 71. The archimedian screw 72 has increasing diameter along its length causing a decrease in cross sectional area available to material passing through the screw press 70. Fluid is expelled from the screw press across filter media 73 disposed along a length of the interior of the screw press and is directed along passage 75 where it can be directed to container 35 of Figure 1. At the end of the filter the residue 103 has been bunched and extrudes from the filter via passage 76 as a presscake which can be directed into bin 41of Figure 1.

Figure 2 shows a variant of Figure 1. In Figure 2, like numerals indicate like portions to Figure 1. Instead of a belt press 30, the embodiment of Figure 2 has a piston press 50. The piston press 50 has a cylinder 51, with an end formed from mesh 52. Moist residue 103a is moved (as for example) by a conveyer belt 29, into cylinder 51, where it rests against mesh end 52. When the cylinder is sufficiently filled with a discreet portion of the moist residue, the supply of residue 103a is interrupted. This can be done by directing conveyor 29 to a holding vessel (not shown) or by turning off the auger 22, so that no material is put onto conveyor belt 29.

Piston 53 is then caused to descend into cylinder 51, compressing the residue 103 and squeezing it, to press out liquid 104. This liquid is collected in a vessel 35. The piston 53 is then withdrawn, and the compressed residue is removed as a presscake 105a. This is advanced on a suitable conveyor belt 42 to a knife 40, where it is cut into pieces, which fall into bin 41 to form product 106a. Product 106a from this embodiment is essentially the same as product 106 from the first embodiment discussed above, except that, depending upon the pressure exerted by piston 53 in cylinder 51, and the length of time that the pressure is exerted, it may be that the presscake 106a from this embodiment will be somewhat dryer than the presscake from the first embodiment. The fact that the presscake can be dryer is of course an advantage, as less subsequent drying is needed.

However, this has to be offset against the fact that the need for filling the cylinder, then compressing the piston into it means that this is a discontinuous process, instead of the continuous process of Figure 1. Generally, the process of Figure 1 requires less labour.

Figure 3 shows a third embodiment of the invention. The same reference numerals are used in Figure 3 as in Figures 1 and 2, where similar things are illustrated.

The embodiment of Figure 3 shows a different type of impeller filter from Figure 1. In Figure 3, the impeller filter is an open vessel generally illustrated as 60, with walls 61 and a mesh bottom 62. The vessel has in it a paddle generally indicated as 63, which has paddles blades 64 rotating about a powered axis 65. The paddle blades 64 rotate, pushing the slurry against the filter mesh 62. This causes the expression of liquid 101, with nut meats 102 in it into the vessel 23 below.

From time to time, the supply of defatted canola 1 and water 2 is interrupted. Paddles 64 are allowed to operate until substantially no more liquid passes through the mesh 62. What remains in the vessel 60 is then a residue 103b, not unlike 103 of the first embodiment or 103a of the second embodiment. The paddle 63 is removed, and the contents of the vessel 60 are dumped onto conveyor belt 29 to be passed to the second stage. The contents are a wet residue 103b.

In the embodiment shown in Figure 3, piston 53 is operated to descend into cylinder 51 to compress the residue 103 pressing out liquid 104. This liquid is collected in a vessel 35. The piston 53 is then withdrawn, and the compressed residue is removed as a presscake 105b. This is advanced on a suitable conveyor belt 42 to a knife 40, where it is cut into pieces, which fall into bin 41 to form product 106b. Solid product 106b is similar in composition to solid product 106 and 106a, and is used as a ruminant animal feed.

In each of the embodiments described, liquid 104 is high in protein. It can be used as a food or animal feed or mixed with liquid 101 (and entrained nut meats 102) for use as a food or animal feed.

The impeller filter 60 of Figure 3 can be used in the embodiments of either Figures 1 or 2 in lieu of impeller filter 10 of those figures. The important thing is that there be an impeller stage filtration, followed by a second stage compression filtration moisture reduction process.

The invention will now be further described by way of an example.

Example

Three hundred kg of canola flakes are slurried with 1500 L of water at 70 degrees Centigrade and mixed for 10 minutes. The slurry is then passed through an impeller-based filtration process with a filter media with pore opening size of 145 microns. The passage results in the generation of an extract containing the bulk of the liquid and light phase solids, and a high-moisture extracted residue. Forty percent of the total dry matter of the slurry is found in the extract formed during passage through the impeller blade filtration system. The bulk of the viscous materials in the slurry are removed during the first phase of the extraction process. The non-extracted residue contains 19% dry matter and becomes the feed for the second phase of the process. Given that the majority of the viscous materials are removed during phase one filtration, the feed is well suited for compression-based filtration with efficient process rates. This material is then processed by compression-based filtration using a belt press as in Figure 1 with a mesh filter media that allows 370 cubic feet/minute air passage. The extract generated during phase two filtration is combined with the extract from phase one to form the total extract of the combined process. The final extracted residue after phase two processing contains 38% dry matter and thus is suitable for cost-effective drying. The extracted residue contains 35% of the initial dry matter. As such the 2-step filtration based system resulted in efficient cost-effective dry matter extraction of a canola flake slurry and generation of extract containing the bulk of cell meat fines and low-moisture extracted residue.

While the invention has been shown and described in particular embodiments, it will be understood that other embodiments will be evident to a person skilled in the art. Therefore, it is intended that the invention not be limited by the particular embodiments, but should rather be given the full extent set out in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

1. A process for separating a protein rich component from a defatted oilseed meal, which comprises the steps of:

(a) mixing a defatted oilseed meal with water to form a slurry;

(b) filtering the slurry by impeller filtration to form a predominately liquid filtrate and a moist solid residue; and

(c) removing water from the solid residue by a compression filtration means.

2. The process of claim 1 wherein said step of impeller filtration comprises continuous filtration of the slurry by auger driven passage through a tubular filter.

3. The process of claim 1 wherein said step of impeller filtration comprises periodic filtration of the slurry by impeller driven mixing in a vessel including a filter medium as a portion of the vessel wall.

4. The process of claims 1 or 2 wherein the step of compression filtration comprises continuous filtration by passing the solid residue between filter belts gradually approaching one another as the solid residue passes between them.

5. The process of claims 1 or 2 wherein the step of compression filtration comprises continuous filtration by passing the solid residue through a screw press.

6. The process of claims 1 or 3 wherein the step of compression filtration comprises filtration discreet portions of the solid residue in compression filtration means comprising a piston chamber including a filter medium as a portion of the

chamber wall by placing the solid residue in the chamber and compressing the solid residue with a piston.

7. Separation apparatus for treating a solid product with water soluble components, which comprises in combination:

(a) means for mixing the product with water to form a slurry;

(b) an impeller type filter to separate the slurry into a filtrate and a moist retentate; and

(c) compression filter means to remove further water from the moist retentate.

8. The apparatus of claim 7 wherein said impeller type filter comprises a tubular filter media housing an auger impeller closely fitting to the filter media.

9. The apparatus of claim 7 wherein said impeller type filter comprises a vessel including a filter media in a portion of the vessel wall and an impeller disposed for movement within the vessel closely fitting to the filter media.

10. The apparatus of claims 8 or 9 wherein said filter is a mesh filter media.

11. The apparatus of claim 8, 9 or 10 wherein said filter media has a minimum aperture of about 75 microns.

12. The apparatus of claims 8, 9 or 10 wherein said filter media has a minimum aperture of about 250 microns.

13. The apparatus of claims 8, 9 or 10 wherein said filter media has a maximum aperture of about 2500 microns.

14. The apparatus of claims 8, 9 or 10 wherein said filter media has a minimum aperture of about 250 microns.

15. The apparatus of claim 7 wherein said compression filter means comprises at least one pair of filter belts gradually approaching one another in the direction of movement of the solid residue between the pair of filter belts.

16. The process of claims 7 wherein the step of compression filtration comprises a screw press.

17. The apparatus of claim 7 wherein said compression filter means comprises a piston chamber including filter media as a portion of the chamber wall and a piston adapted to be received within the piston chamber whereby solid residue within the piston chamber is compressed against the filter media by the piston.

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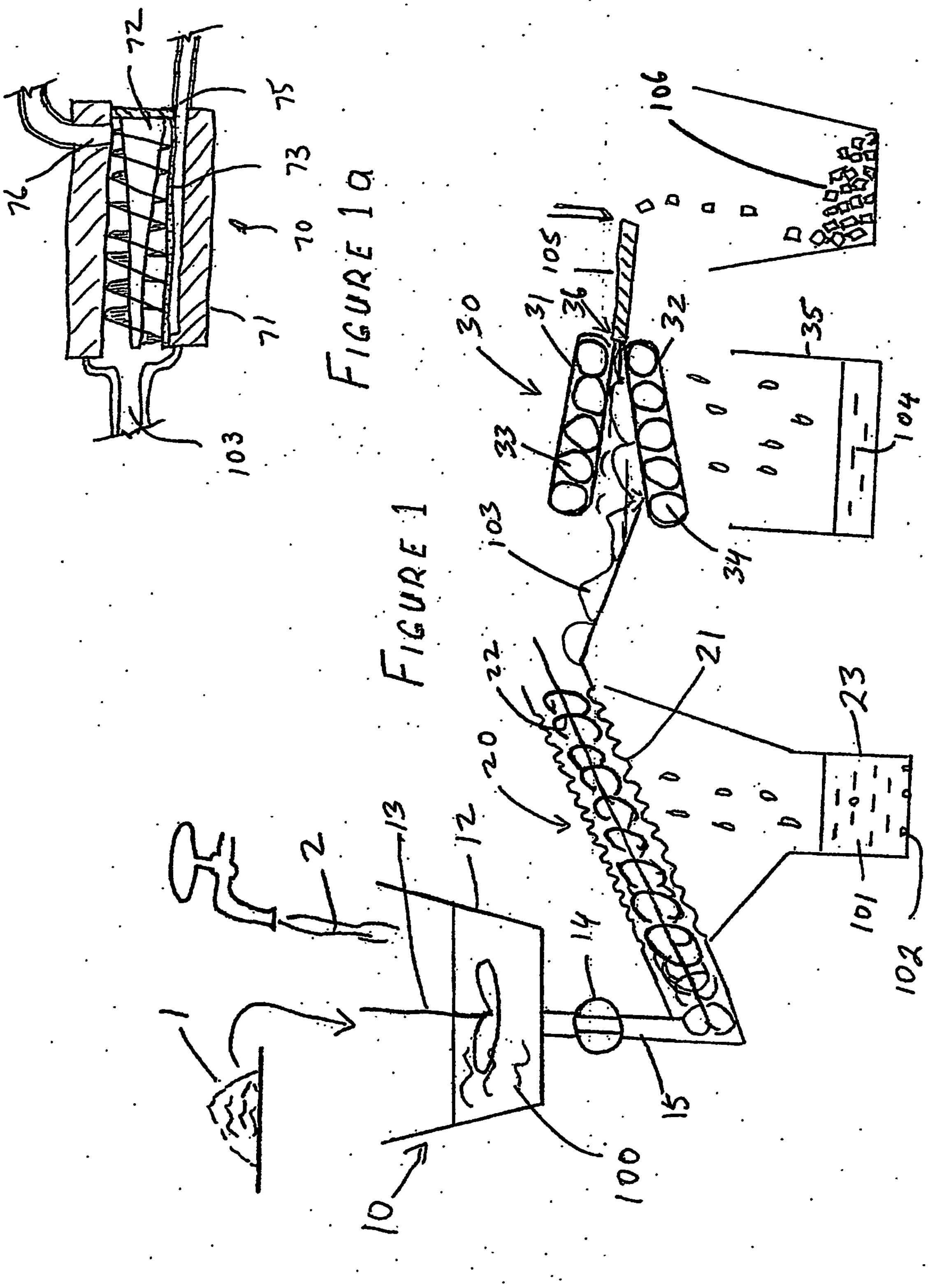

FIGURE 1a

FIGURE 1

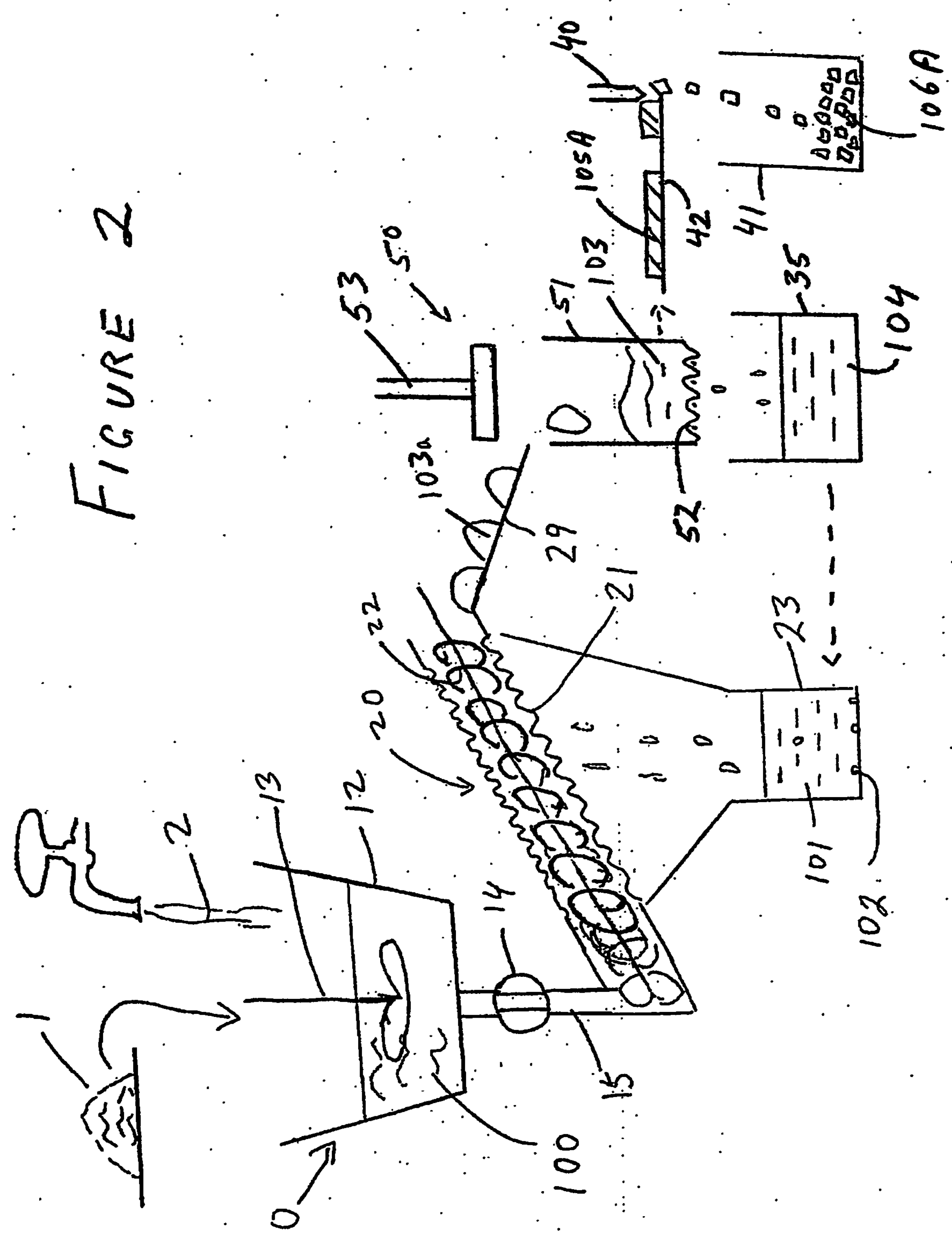
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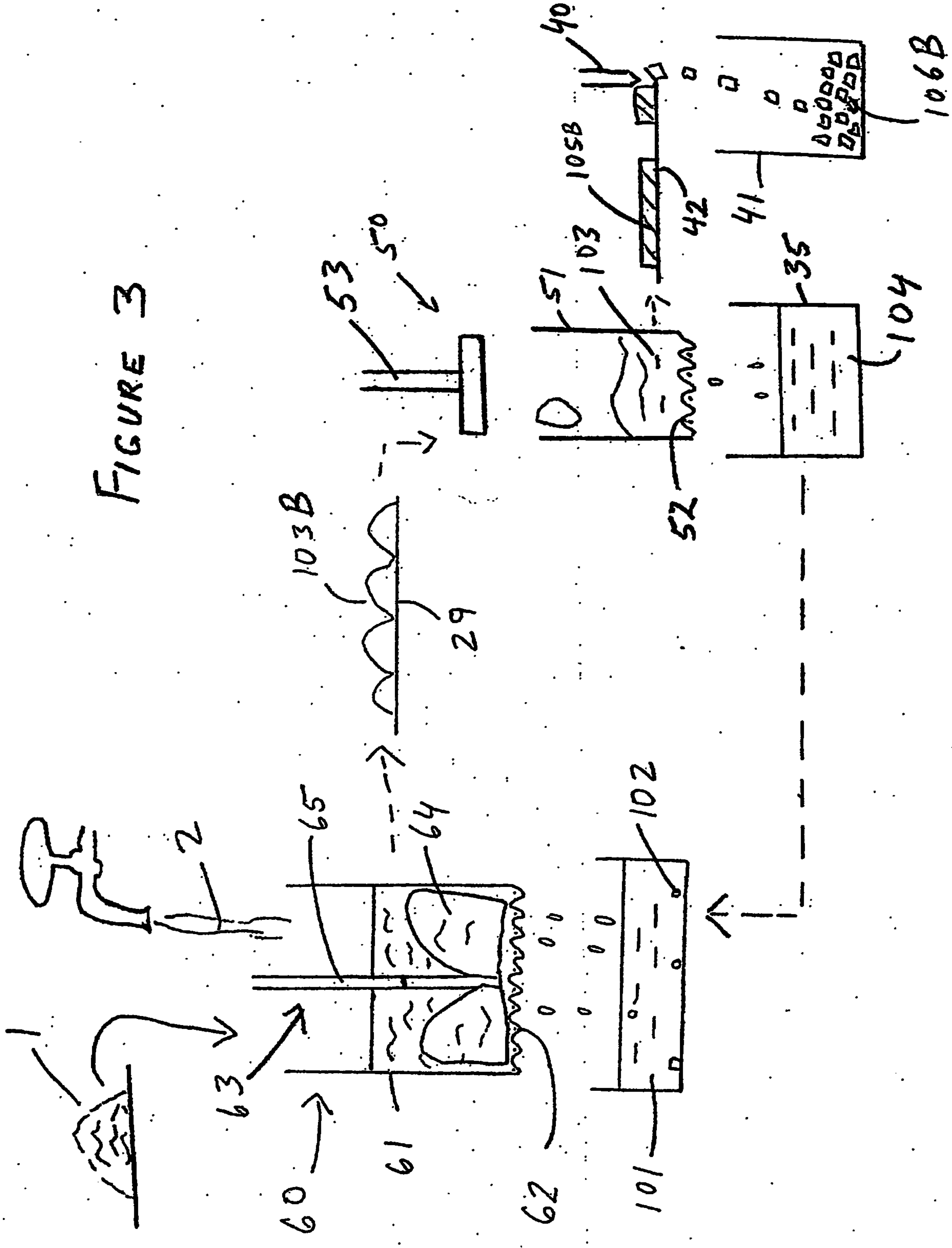
FIGURE 2

FIGURE 3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